Acquisition of Ice-Tethered Profilers with Velocity (ITP-V) Instruments as a contribution to the Marginal Ice Zone DRI

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LONG-TERM GOALS

The PI group seeks to observe the upper Arctic Ocean using autonomous instrumentation and build understanding of the physical processes controlling the evolving thermohaline stratification, the ocean currents and air-ice-sea interactions on time scales of minutes to interannual.

OBJECTIVES

This award is supporting the acquisition of 4 Ice-Tethered Profilers with Velocity (ITP-V) instruments as a contribution to the Marginal Ice Zone DRI. This specific research element is designed to observe the seasonal evolution of the upper-ocean stratification, document the time-varying ocean currents and characterize the turbulent ice-ocean exchanges of heat, salt and momentum as the sea ice cover retreats poleward in spring/summer.

APPROACH

The acquired ITP-V's will be used to quantify the seasonally varying upper-ocean stratification and velocity field, and the turbulent ice-ocean exchanges of heat, buoyancy and momentum in the Arctic MIZ. An array, consisting of a north-south line of four ITP-Vs spaced approximately 100 km apart, will be deployed in spring 2014 in fully ice-covered conditions. The ITP-Vs will sample through the melt season following mechanical displacements of the ice as the ice edge sweeps north. High spatial (1 m) and temporal (2 hr) resolution profile observations of upper-ocean temperature, salinity and velocity will be provided in near-real time from the ice-ocean interface to 250 m depth. This high

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temporal resolution will allow inertial motions and internal waves to be quantified. In addition, direct estimates of the turbulent vertical fluxes of heat, salt, and momentum just below the ice-ocean interface will be made every four hours. Data from the first prototype ITP-V deployment has shown the benefit of simultaneous observations of ice velocity, ocean velocity, turbulent fluxes, and mixed layer properties. The ITP-V array will document the change in internal wave properties, turbulent fluxes, and entrainment of subsurface heat into the mixed layer as the sea ice concentration evolves during the melt season. The ITP-V array will additionally serve as a moving reference frame for other autonomous observations, will capture many of the processes important to the seasonal evolution of the sea ice cover, and will provide initialization and/or validation data for numerical models.

The ITP-V is a variant of the ITP system that has contributed to sustained observations of the Arctic Ocean below sea ice since 2004. The ITP concept is, in short, Argo of the Arctic - a word play on the international program maintaining an array of profiling floats throughout the temperate oceans. Briefly, the ITP system consists of three main components: a buoyant surface instrument package that typically sits atop an ice floe, a weighted, wire-rope tether of arbitrary length (up to 800 m) suspended from the surface package, and an instrumented underwater unit that travels up and down the wire tether (Figure 1). The current design of the ITP surface expression is a conical-shaped buoy that houses a controller, inductive modem electronics, a GPS receiver, and an Iridium satellite phone with associated antennae and batteries within a watertight aluminum housing capped by an ultra-high-molecular-weight (UHMW) polyethylene dome. The electronics case sits within a foam body designed to provide buoyancy for the plastic-jacketed wire rope tether and end weight should the ice fracture or melt, and to provide modest protection in the event of ice ridging. The profiler unit (much like an Argo float in shape and size) mounts on the tether and cycles vertically along it. Via an inductive modem, raw sensor and associated engineering data files are relayed from the underwater vehicle to the surface buoy at the completion of each one-way profile, which then transmits them to a logger computer at WHOI by satellite. The ITP-V instruments add a multi-axis acoustic-travel-time current meter and associated attitude/motion measuring unit to the standard ITP sensor suite to make direct, 3-D observations of ocean flow (Figure 2).

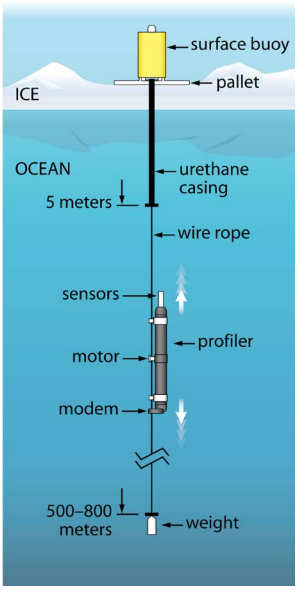

Figure 1 (left) Schematic drawing of the Ice-Tethered Profiler instrument system

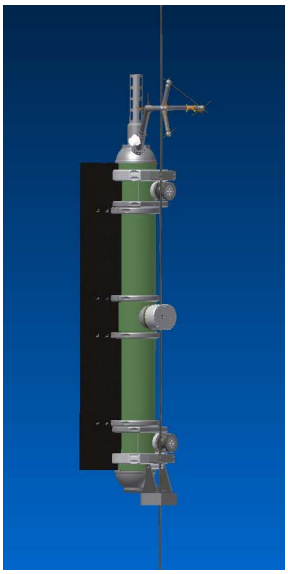

Figure 2 (right) Engineering drawing of the Ice-Tethered Profiler with Velocity instrument system.

WORK COMPLETED

The work plan for the PI's contributions to the MIZ DRI called for assembling and fielding a prototype ITP-V system in summer 2013 to validate several improvements to the previous versions of the instrument prior to finalizing the design of the systems funded under this DURIP award. That prototype instrument was deployed in August, 2013 and the PIs are now evaluating it's performance. The main subsystems of the 4 ITP-V instruments have been ordered and/or now under construction.

RESULTS

The 4 ITP-V systems are currently under construction.

IMPACT/APPLICATIONS

Observations and insights deriving from the MIZ program will advance understanding of ice-ocean interactions and their parameterizations in numerical models. In turn, predictions and assessments of the future state of the Arctic Ocean will result.

RELATED PROJECTS

The present project, a component of the Marginal Ice Zone DRI (see http://www.apl.washington.edu/project/project.php?id=miz) is related to all the fellow MIZ projects. The closest connection is with the project "Autonomous Observations of the Upper Ocean Stratification and Velocity Fields About the Seasonally-Retreating Marginal Ice Zone," Award Number: N00014-12-1-0140.